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## Design explorations for an online environment to promote metacognitive processing through negotiated assessment

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### *Abstract*

*This study uses design-based research to explore how negotiated assessment contributes to students' metacognitive processing. Metacognitive processing is shown to be linked to self-regulation and the development of generic skills. The research derived a conceptual framework from the literature that was integrated into a face-to-face learning strategy and evaluated. The results of this study were then used to refine the learning design, and another study was conducted with a view to explore its potential to be instantiated into an online electronic performance support system. Results from the second study are discussed and a new conceptual framework is proposed to promote metacognitive processing using negotiated assessment. Key metacognitive processes of planning, monitoring and evaluation form the basis of the new learning design with a view to engage students in a structured process of self-evaluation, goal setting, team planning, contractual agreement and monitoring, as well as summative evaluation.*

### Introduction

Good learners are often described as 'self-regulating'; that is, they 'activate and sustain cognitions, behaviours, and affects, which are systematically oriented toward attainment of their goals' (Schunk & Zimmerman, 1994, cited by Boekaerts, 1997, p. 171). Teachers usually recognise self-regulation through students' abilities to apply themselves to their work, their abilities to generate learning strategies, and in behavioural terms actual measurable outcomes such as attendance, timely submission of assignments, and so on. However, such outcomes are inevitably underpinned by a variety of cognitive and emotional processes that come from a high level of self-awareness and manifest themselves in the formation of strategies to learn and manage that learning.

Self-awareness has always been an important educational construct. *Metacognition* can be defined as 'knowledge and beliefs about thinking and the factors affecting thinking' which regulate 'the articulation of strategy and knowledge' (Pressley, 1998). As such it is a necessary precursor to self-regulation. Wilson (1999) argues that the term *metacognition* can be used in 'vague, confusing, and often contradictory' ways and can be used to describe a range of disparate higher-level cognitive skills. In spite of this apparent ambiguity of the concept, however, she attempts to distil these disparate elements and defines metacognition as 'awareness individuals have of their thinking and their evaluation and regulation of their thinking'.

There is a growing emphasis in higher education institutions that students should be developing skills that go beyond the curriculum. These include teamwork skills, problem-solving skills, decision-making skills, communication skills and information literacy skills (Australian National Training Authority, 1998; Bennett, Dunne, & Carre, 1999; Candy, Crebert, & O'Leary, 1994; Dearing, 1997). Metacognition would appear to have a role in this as contemporary research appears to support the contention that using strategies that engage students in evaluating and regulating their learning can assist in developing these skills (Boekaerts, 1997; Jonassen, 1996). These strategies in conjunction with online tools can provide ideal settings to help promote learning as well as professional skill development.

The purpose of this project was to integrate the areas of metacognition, instructional technologies and teamwork with a view of developing students' generic skills as well as regulating their own learning. The theoretical foundation was on the use of metacognitive theory to help provide guidance on developing important work and life skills. Key issues include:

- Metacognition as key enabler in the development of generic skills and their importance to contemporary education.

- Extension of traditional linear approaches of “*Plan, Do, Review*” to help promote iterative and internally reflective ways of engaging students in regulating their own learning, to help progress the value of metacognitive theory.
- Enabling students to make better decisions about what to study and what roles to take in teams with a view of developing a stronger self-awareness about their skills.

The study was conducted around the activity of negotiated assessment. The researchers’ previous experience with negotiated assessment has found that students’ perceptions of themselves as learners evolved during the process and that these changes to self-awareness, self-monitoring and strategy use were metacognitive in nature, although this evidence was not always positive. For example, students showed less confidence in their understanding of themselves as learners after having engaged in negotiated assessment than before (McMahon & Luca, 2005).

In the second iteration of the study students deliberately engaged in a strategy that involved metacognitive processing through negotiated assessment. The outcome was intended to be a conceptual framework to underpin the next iteration - the development of an online Electronic Performance Support System (EPSS) to engage learners in these processes. The study is therefore conducted around four phases:

- Review of literature and development of conceptual framework.
- Integration of conceptual framework into a learning strategy to be implemented within a face-to-face environment.
- Implementation and evaluation of the face-to-face strategy to explore its potential to be instantiated into an online EPSS.
- Development of an EPSS to promote metacognitive processing.

This paper outlines the results of the first three of these stages.

## Metacognitive processing

Being an internal state, it is difficult to expose metacognitive awareness from more general metacognitive activity. Inevitably, discussions of metacognition are tied in with discussions of the overt use of monitoring and strategy development, as that is how it is manifest (Schraw, 1998). This position is further reinforced by Jacobson (1998) who defines metacognition both as ‘knowing the process by which one learns’ (p. 3) and, in citing Borokowski, Carr, and Pressley (1987) as ‘the self-monitoring of, and conscious use of learning strategies’ (p. 4). Metacognition, therefore, is defined by the nature of processing it engenders and must be grounded in a domain of knowledge or skill in order to engage the conscious use of strategies and self-monitoring processes.

Nelson and Narens (1994) identify the relationship between the meta-level and the object-level of cognition through a reciprocal flow of control and monitoring (Figure 1). In Nelson and Narens’ concept, a process monitoring nurtures metacognition, likewise the activation of control processes exercises it.

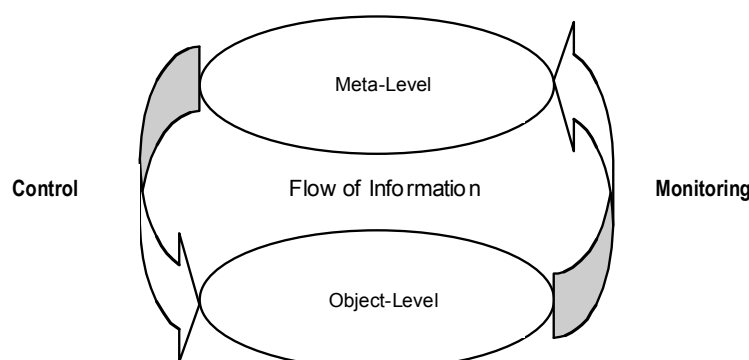


Figure 1: A model of metacognition (Nelson & Narens, 1994)

Fogarty (1994) defines three components of monitoring:

- planning
- monitoring
- evaluation.

One way of exposing these processes within the domain of teamwork is through self and peer assessment. Such assessment involves students making judgements about their own learning and that of others, which contributes to the development of autonomous, responsible and reflective individuals (Sambell, McDowell, & Brown, 1998; Schon, 1987). A review of the literature on self peer assessment indicates that to promote the development of these skills, learning should be designed to encourage participants to engage in the following processes which link closely to the reflective processes of planning, monitoring and evaluation:

- Have a clear understanding of the objectives (Orsmond, Merry, & Reiling, 1996; Stefani, 1994).
- Identify valid assessment criteria (Falchikov, 1995; Ford, 1997; Klenowski, 1995; Sluijsmans, Dochy, & Moerkerke, 1999; Sullivan & Hall, 1997; Topping, Smith, & Swanson, 2000).
- Accurately and objectively judge success or failure (Oldfield & MacAlpine, 1995; Woolhouse, 1999).

## Design and implementation

The initial goal was to engage students in the processes of planning, monitoring and evaluation through peer review techniques. These were identified above using a learning strategy that instantiated these processes in a manner that was conducted off-line, but could be assisted through the design and implementation of an online tool. This section, therefore, describes the processes involved in developing and implementing the off-line strategy. The basis for this approach is design-based research as advocated by the Design-Based Research Collective (2003). This approach is often ‘mistakenly’ described as design experiments (Design-Based Research Collective, 2003) and rather than using analytic approaches to experimentation in a quest for objectivity to test single hypotheses, this approach aims to develop a profile of a learning situation in a more qualitative manner. It acknowledges the context-laden nature of instructional settings, and the multiple variables inherent in these. Instead of controlling variables and using fixed procedures in social isolation, the aim is to characterise the situation, and allow flexible design revision and social interaction. Ultimately the researcher is a co-participant in design and analysis rather than an experimenter (Collins, 1999). It is ‘pragmatic as well as theoretical in orientation in that the study of function — both of the design and of the resulting ecology of learning — is at the heart of the methodology’ (Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003, p. 9). This combination of both practical and theoretical components is underscored by Cobb et al. (2003) who identified five distinct features:

- A focus on developing a class of theories about the process of learning and the means that are designed to support it.
- An interventionist approach, acting as a test bed for innovation.
- Building on the first two features, an aim of creating conditions for developing theories, but placing these theories in harm’s way.
- An iterative approach to design — the intended outcome being an explanatory framework that specifies expectations that become the focus of investigation during the next cycle of inquiry.
- The theory generated must do real work, rather than developing a generic theory that may be difficult to put into practice, design experiments speak directly to the types of problems that practitioners address in the course of their work.

This focus on theory building through practical application and an iterative approach to development make this model a suitable one for a study such as this, which aims to explore metacognitive processing, but with the practical goal of developing a product that can lead to effective learning through negotiated assessment.

## Context

The research was conducted with a group of 38 final year students enrolled in the Interactive Multimedia course at Edith Cowan University (IMM3228: “Project Management Methods”). The unit was designed to encourage the development of a range of professional skills, as can be seen from the following learning outcomes:

- i. Apply a range of project management and generic skills appropriate to the development of multimedia projects including time management, collaboration, communication, self-assessment, peer-assessment, task management, problem solving, information management and learning to learn skills.
- ii. Make a significant contribution to a team-based multimedia development project.

The learning environment required students to form teams and develop web sites for clients that conformed to industry requirements. The teamwork was carefully structured to allocated clear and concise responsibilities in a fashion that supports the development of important professional skills (Collis, 1997; Klemm & Snell, 1996; English & Yazdani, 1999).

Students were encouraged to select own teams and tasks based on their skills and aspirations for future employment. Team-based assessment is 50% of the overall mark (the other 50% being an exam), and included the development of a project proposal, design specification, metrics, evaluation report, post-mortem and a web site. Students are required to decide on:

- *team role* — each team requires a project manager, graphics designer, programmer and instructional designer. Roles could also be shared, combined or created (e.g. media designer, content developer, evaluator and tester). These details were negotiated and finalised in the first two weeks of the semester; and
- *project topic* — selected by students to enhance their skills, though considered for suitability by tutors i.e. team roles, client, clearly achievable objectives value of final product; and
- *clients* — team members considered how to approach clients and establish what commitment and input they would give the project. The client was requested to pass comment on the quality of the final product.

Student teams were also required to complete eight problems using a custom built online application. These represented key topics covered in the lectures, and were designed to encourage students to use the given resources to research solutions (book, readers, lecture material URL's, library and expert opinion). Teams made decisions about what resources to use, what "angle" to take in solving the problem and which team members were involved (as negotiated in the team contract). Completed tasks were then posted online and assessed by other teams and tutors. The topics were assessed according to the following criteria:

- Correct focus in answering the question, with relevant facts and research supporting your perspective.
- Synthesis of ideas into a cohesive solution.
- Correct grammar and spelling.
- A clear introduction and conclusion.
- Proper referencing of information sources.
- Under 500 words, excluding references.

A custom built online courseware management system (<http://www.scam.ecu.edu.au/>) was used to deliver the content in blended mode, and the final product is compiled on the university server (<http://studentprojects.scam.ecu.edu.au>) as an online CV to help students promote themselves to potential employers. The web site contains the project name, description, team members, their roles, web site URL, and documentation (project proposal, design specifications, metrics, evaluation and post-mortem).

The key design goal was to develop and promote an authentic context that provided real and tangible benefits for the students. Not only would the students end up with a CV item they could show potential employers, but this unit also provides an opportunity for the students to identify their strengths/interests and nurture them in a supportive environment.

### ***Designing the negotiated assessment learning strategy***

This strategy has been developed over a number of years through gradual refinement of teaching and learning approaches based on design based research. The focus has been to design a learning environment that integrates teamwork with negotiated assessment to help students and tutors make more informed decisions about transferring marks between team members as well as helping students understand the value of their own and others contributions. The design focus has been on learning activities that are authentic, self-regulated and reflective (Luca & Oliver, 2003). Project work is integral to this unit and students liaise with real clients to scope, design, develop, evaluate, cost, schedule and track projects, reporting on discrepancies and developing documentation that has direct relevance in the industry. The final product and documentation is hosted on a university server for students to use as an electronic CV to enhance employment opportunities. This authentic context provided key motivational value in which students were encouraged to take ownership for their own learning by selecting their project topic, team members and desired team roles to match their aspirations for employment.

Students are firstly required to complete a *Self-Assessment Questionnaire* designed to help them gain an understanding of their team skills, i.e. administrator, analyst, negotiator, verbal communicator, written communicator, listener, motivator or decision-maker. This helps determine their skill deficiencies and strengths when working in a team. Once this is complete, they then develop their *Team Operational Plan*, where they outline the operating rules of the team, including individual goals, team goals, meeting strategies, task assignment issues and communication, a decision-making process and conflict resolution strategies. The final stage in the process is the *Student Contract*, which outlines the main (macro) responsibilities individual students have in the team. This is tied into the unit's assessment criteria and allows students to clearly state major roles and responsibilities (see Table 1):

Students use the team contract to negotiate their assessment items and continually reviewed these for each assignment, by reflecting on how successful they and peers had been in completing the tasks outlined in the contract. Each row in the team contract represents a key assessment point that students could consider how heavily they want to contribute to, based on their aims for future employment and current skill sets. With four students in a team, each student should contribute 25% of the overall marks. However, this is not mandatory, and students can specify how much of the “assessment pie” they want! This negotiation assessment process is conducted in two stages. Students need to consider:

- Estimated contributions — at the beginning of the semester students commit to completing a series of tasks (approximately 25% of the total in a team of four students) by specifying which assessment tasks they want to contribute to, as well as the predict the quality they are aiming for.
- Actual contributions — when each of the team assignments are submitted, the team contract is re-submitted. Students then complete the “Actual contributions” columns, with a review of what marks they actually contributed to, and also with a rating of the actual quality they presented. This is agreed to by the whole team and the tutor, and then submitted for marking. The reviewed assessments and quality standards agreed to are then used to help distribute marks in the team using tutor led peer assessment sessions.

It is anticipated that having students negotiate each assessment item would promote responsibility within the team, as well as define the quality expected from each team member. So, when the actual assignments are submitted, it would be clear how much effort/quality each team member had contributed. Also, the fact that the assignment components are authentic, and aligned with multimedia project management good practice, would help motivate students contribute to this process.

Beyond the issues of fairness and equitability of marks distribution, however, this negotiation also involves students planning their learning, by setting goals and estimating their performance both in terms of outcome (mark) and process (quality of work). They are required to evaluate these goals against actual achievement when the assignment was submitted. Through this cyclical process and through the internal, parallel and external feedback mechanisms of peer, tutor, and self-assessment, students are engaged in a continuous process of self-monitoring.

The implementation of the team contract was based on planning, monitoring and evaluation (Dirkes, 1985). By week three students had to plan and negotiate with their team members which assessment items they would be responsible for (“EM” in Table 1), as well as predict the quality of these (“EQ” in Table 1). As the semester progressed, students were required to continually monitor their own performance in terms of their stated plans as well as their team members’ commitments (as agreed to in the contract). If they felt the team was not progressing as agreed, they could inform the tutor through the peer assessment tool. As well as ongoing modification of their initial plans, students formally evaluated their performance and that of their peers when the assessment item was submitted. They did this by entering the actual mark and quality of their contributions into the team contract (“AM” and “AQ” in Table 1).

Table 1: Team contract

Assessment Items	%	Name 1				Name 2 etc..			
		EM	EQ	AM	AQ	EM	EQ	AM	AQ
Online tasks	16								
Project proposal	10								
Design specifications	5								
PM Doc 1	2								
Application development	5								
Presentation & online CV	2								
Evaluation report	3								
Metrics report	3								
Post mortem	2								
PM Doc 2	2								
Total	50								
Signatures									

(EM = Estimated mark; EQ = Estimated quality; AM = Actual mark; AQ = Actual quality)

## Findings

Data was gathered following the implementation of the negotiated assessment strategy to evaluate the approach. The data took the form of focus groups conducted following the implementation where students reflected on their experiences throughout the semester. The discussions were not formal, but questions were organised around their impressions of the planning process they engaged in, the value and equity of the teamwork, and how their learning evolved through the negotiation they engaged in. These were developed from statistical data gathered from the previous instantiation of the process. The use of focus group data provided a richer form of data for analysis and enabled more detailed recommendations to be developed. A constant comparative approach to analysing the focus group transcripts enabled patterns to emerge that could be categorised according to three main types of finding:

Findings relating to metacognitive planning, monitoring and evaluation; findings relating to the fairness of negotiated assessment; and findings relating to the implementation of the strategy.

### ***Metacognitive planning, monitoring, and evaluation***

The product appeared to be effective in engaging students in metacognitive processes. The self-evaluation at the beginning of semester, in particular provided a strong grounding for planning, in that students could see 'where each of the team members stood'. It also operated well as 'an icebreaker as well as a really useful way of helping allocate the tasks'. Despite this, one student noted, 'I didn't really understand the roles defined in the contract [so] wasn't sure which one would be the most appropriate for me'

This planning seemed to provide a strong basis for the monitoring that took place as students modified their contracts through the semester. One student observed that the student contract was 'a great way to clarify ideas and work out which ideas are most relevant or most useful to use in the project' while another identified value in the contracts in the way he managed his learning, claiming, 'it was useful to help me think about learning in a different way. Having to consider the needs of the client and team is challenging. It's not just me any more so you have to try and fit in to make it all work better.' It appeared therefore that the monitoring inherent in student contracts exposed the teamwork process in ways that were not consciously articulated before. This led to some reconfiguration of the way some students saw themselves by the end of the semester. One project manager admitted to being 'overconfident as the PM' but then 'ran a bit overtime', acknowledging, 'I realise now that I didn't judge things properly. Next time I'll be more aware of the timing'.

### ***Fairness and equity***

For the negotiated assessment strategy to be effectively implemented within a university course, it would need to provide a fair and equitable basis for the allocation of marks. The strategy appeared to enhance this aspect of teamwork. Not only did it make students more aware of the processes within it ('having people ... giving different perspectives and ideas helps to produce better ideas') but also on the whole students found the negotiated assessment a useful means of 'balancing marks to work out if everybody has contributed the same value'.

Nevertheless it appeared that this only worked when the process was mandated and appropriately implemented. One student commented 'the whole group was disappointed with one team member, but nobody addressed this point directly'. Another commented:

Our team behaved in a reserved fashion and didn't really engage with the process of negotiating marks. Our [project manager] didn't really enforce these things, as she had confidence that things would improve. But they didn't. She really took the easy way out.

It appeared therefore that to be successful, the process needs to be fully owned by students and needs to be enforced – something that may require assistance from a tutor within a novice group.

### ***Implementation issues***

The focus group provided useful feedback regarding the implementation of the negotiated assessment strategy that may prove useful when considering a further iteration. One of the findings was that student contracts were entered into too early. Doing this later would ensure 'everybody is clear about expectations and rolls'. Common to several comments was a desire for tutor involvement in the negotiation process, both in assisting with initial negotiation and 'checking the contract each week'. To some extent this would appear to defeat the purpose of performing in teams, yet one student noted 'the tutor would be better than the PM to help enforce the contract'. It was also suggested that clients be involved in the process so 'they know exactly what their requirements are and know what they have to do'.

Overall, it appears that scaffolding could have been improved. While one tutor was heavily involved in the process, another was more hands-off in his approach. It appeared that students valued support in the early stages of estimating contributions and defining what was actually involved in different roles of a project. This did not happen for all teams. Finally, there was some concern with the repetitiveness involved in filling out the contract at regular intervals. It is expected that the potential of an online environment in summarising this data and carrying roles and responsibilities from one period to another would alleviate this issue.

### **Recommendations**

Overall it appeared that this instantiation of the negotiated assessment strategy provided a strong foundation for teamwork that engaged students in metacognitive planning, monitoring, and evaluation, while assisting in the fair distribution of marks. Considerations to be carried through to the design of an online EPSS to manage this process can be summarised in the following way:

- Provide an effective means to support and guide students initial allocations of roles and the reconfiguration of these for students.
- Have tutors involved in the process of monitoring the evolution of the student contract and ensuring all students participate.
- Make the best use of an online database system to reduce repetitive functions such as carrying over roles and percentages from one period to the next.

### **A new model**

Based on this study, a new strategy will be adopted that integrates teamwork with self/peer assessment strategies. Using the feedback obtained in this last design iteration, care will be taken in this new instantiation to provide extra student support when making their initial allocations of team roles and responsibilities. This will be supported with an online EPSS application, designed to integrate a self-assessment questionnaire, team operational plan and student contract. This, with structured tutor support should provide the necessary structure and support to help students gain a clear understanding of how their team will be configured and responsibilities allocated. The online EPSS will also help reduce repetitive tracking tasks required on a weekly basis.

The online tool (open source) will be developed with administration, tutor and student views. Educators will have the flexibility to set up assessment criteria through the use of a wizard to help contextual the tool to any discipline. As shown in Figure 2, the tool will contain the following five modules:

- i. *Self-assessment questionnaire* with feedback for student skills and attributes. This will help students formulate their own skill deficiencies and strengths.
- ii. *Team operational plan* will be based on the results of the self-assessment questionnaire, as well as students' career aspirations. The operational plan will outline the operating rules of the team as well as the negotiated performance criteria for each allocated macro tasks.
- iii. *Student contract*. Outlines the main (macro) responsibilities individual students will have in the team. This will be tied into the unit's assessment criteria and allows students to clearly state what major roles and responsibilities they will take.
- iv. *Monitoring*. Each week, students enter their actual progress/performance (time, percent complete, quality and comments). This is compared to their estimated progress and performance as stated in the contract. This information is summarised and presented in graphical and tabular format to show how their roles and contributions within the team are evolving. This section concentrates on micro tasks that are related to macro tasks outlined in the student contract.
- v. *Overall evaluation and reflection*. Is completed at the end of semester, and shows summarised data such as comments, personal reflections and rationales for changes in estimations that evolved during the semester. The emphasis here is for the students to explain *why* some tasks went off track, and why others were successful, i.e. lessons learnt, skills that need enhancing and also areas of strength that can be carried forward in career options. These will map back to unit outcomes and indicate the level of achievement obtained against those outcomes (low, medium or high) i.e. Performance criteria against unit learning outcomes.



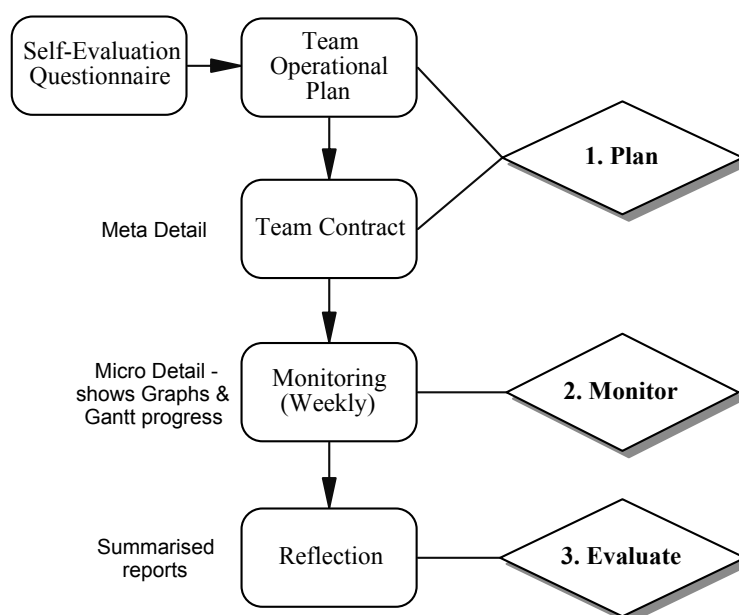


Figure 2: A metacognitive approach to promote fair and equitable teamwork

## Conclusions

This design-based research has led to recommendations to inform the development of an EPSS to manage the process of negotiated assessment in a manner that promotes metacognitive processing. The key recommendations of a system that can provide scaffolding for developing student contracts and a means of monitoring them in a system that is efficient and avoids repetitive time-consuming tasks will be manifested in a tool that integrates the key processes of planning, monitoring and evaluation through the activities of developing operation plans, team contracts, weekly monitoring and reflection. Following the development of the tool a further iteration of design-based research will be implemented to evaluate and continuously improve the product.

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